

Proposed Changes to Lake Thurmond Releases to Mitigate Drought Impacts

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Executive Summary

As the ongoing drought in the southeastern U.S. approaches its third summer, the Savannah River reservoir system operated by the Army Corps of Engineers (hereafter referred to as the Savannah System) is experiencing extreme pressure and difficulties. As of July 23, 2008, the system has only 46% of its conservation storage remaining. Hartwell and Thurmond, the two large storage reservoirs, are approximately 12 feet below normal pool levels. Hartwell has less than 57% of its conservation storage left, and Thurmond has only 28% of its conservation storage remaining.

The recharge season of the year has long gone, and the status of the system is of particular concern to many parties in both Georgia and South Carolina depending on the resources provided by the storage in these reservoirs. Low inflows to the system last year and early this year raised the prospect that the system storage may be exhausted in the near future and a consequent transition to Level 4 operations (only releasing inflow) may be on the horizon.

Based on the Information Paper provided by the Army Corps of Engineers (Corps) and information compiled by other cooperating institutions, Georgia EPD, in coordination with SCDHEC and SCDNR, conducted a thorough analysis of potential operations of the system under a variety of hydrologic conditions. Georgia EPD, SCDHEC, and SCDNR propose that the current operation (i.e. a Thurmond release of 3,600 cfs) be revised to maintaining a 3,600 cfs release from Thurmond Dam in the warmer months of March through September and reducing the release to 3,100 cfs in the cooler months of October to February of next year.

The analysis conducted by Georgia EPD, in coordination with SCDHEC and SCDNR, indicated that such operations would be able to stabilize the system and substantially reduce the speed of decline in system storage. Even under a very pessimistic assumption of inflow (10% worse than the lowest historic inflow) for the next three consecutive years, the proposed operations would be able to prevent the system conservation storage from being depleted. System storage would only approach depletion toward the later part of 2011, with the assumption that worse-than-the-worst hydrology will persist through the years (a highly improbable event).

Our analyses indicate that water users along the river will not be impacted as a result of this revised operation. Also, modeling and field observations indicated that it is unlikely that water quality will be of a concern. Further modeling can be conducted if stakeholders raise additional concerns. In addition, water quality monitoring stations will need to be enhanced at strategic river locations to ensure that there is sufficient real time data available to evaluate and appropriately respond to during modified dam operations.

With respect to intake limiting factors, some of the intakes at the lower reaches may experience little margin in their access to water and thus their functionality. If the lowest incremental flow (recorded in 2007) were to take place again this year, some intakes may not function well in the short period of a few days. However, there are actions that can be taken to mitigate the impact, such as drought-proof engineering measures that will either deepen the bottom elevation at the intake or elevate the surface elevation, or adaptive management measures whereby the facility monitors the river elevation to make sure that sufficient flow takes place when incremental flow is not sufficient. Vulnerable facilities all across the basin will be part of a process that will ensure that proper emergency management measures are incorporated into local planning during this drought emergency.

Background Information

The Savannah River Basin has been experiencing a drought since early 2006. Rainfall and resulting stream flow have been particularly low, causing the reservoirs to drop faster than during previous droughts. If low inflows persist or deteriorate, the current drought could become the new drought-of-record for the basin.

The Corps manages its three impoundments on the Savannah River as a system and uses a Water Control Manual to describe how it will operate those projects. The Drought Contingency Plan is a component of that Manual and was developed (1) to address the effects of the Corps' operation on those impoundments and the downstream portion of the river, and (2) to assist the States of Georgia and South Carolina in drought contingency planning in their water management responsibilities for the Savannah River Basin.

The Corps' 1989 Drought Contingency Plan (DCP) and a 2006 Environmental Assessment (EA) describe activities that would be conducted during four stages of a continuing drought. Those four stages correspond to different lake levels. When the reservoirs reach the Level 1 trigger elevation, the Corps issues a public safety advisory concerning recreational use of the reservoirs. The Corps also reduces discharges from the reservoirs when Levels 1-3 are reached. When Level 4 is reached, the conservation pools are empty. If drought conditions persist after Level 4 is reached, discharges are further reduced to the point where the outflow from the lakes equals the net inflow.

The actions the Corps would take surrounding the Level 4 trigger were never evaluated in

detail when the plan was originally developed or during the 2006 Update. The Reservoir System Simulation modeling conducted to analyze the effects of the various operational scenarios during development of the 1989 DCP and its 2006 EA for the DCP Update always indicated that the lakes would not reach the bottom of conservation pool. This modeling was conducted using inflows that were the drought of record at that time. Sensitivity analyses revealed that the drought would need to extend three additional years to reach Level 4. Therefore, detailed consideration was never given for the best way to operate once that trigger was reached.

It should be noted that when a new drought of record takes place, the Corps' operational objective should always be to avoid ever reaching the bottom of the conservation pool. This requires a constant evaluation of the current operations and the update of the drought of record. If the current drought becomes the drought of record, then additional measures not included in the previous Manual or Drought Contingency Plan should be considered and evaluated to achieve this objective.

Status of System and Issue of Concern

As of 8:00 am July 23, 2008, the federal reservoirs on the Savannah River have 1.19 million acre-feet of conservation storage remaining. This is equivalent to 46% of the system conservation storage. Hartwell has 57% of its conservation storage remaining, while Thurmond has only 28% of its conservation storage available.

The recharge period in 2008 is over at this time, and both Hartwell and Thurmond are roughly 12 feet below their respective normal pool levels. Through the summer months, the evapotranspiration rate will increase, making it all but impossible for the reservoirs to meaningfully gain any storage during this time. This holds true regardless of the prospect of precipitation in the summer, even with the overly optimistic assumption that normal rainfall takes place.

Recent updates from climatologists and meteorologists suggest that it is likely that the current drought will extend into this summer and beyond. If this holds true, it is expected that inflow to the reservoir system will remain low or at least below normal, making it a likely scenario that the Corps will need to use storage to augment releases prescribed by the operation Manual and the Drought Contingency Plan.

If the drought persists or deteriorates, it is not inconceivable that the limited conservation storage will be exhausted, or at least be depleted to an intolerable extent. It is extremely important that all measures be evaluated to prevent the depletion of the Savannah System conservation storage. The following sections of this report document contemplated ways to achieve this.

Principles of Operations

We believe the principles of operating the Savannah System are the following: (1) To the extent possible, the Corps should try all it can to avoid depleting the conservation storage. (2) In order to achieve that, the Corps should take early measures to avoid ever reaching the bottom of the conservation pool. (3) The Corps should more explicitly identify the elevation and flow thresholds below which serious impacts take place at facilities across the basin. (4) If hydrologic conditions are such that an early intervention is unavoidable, then the Corps should identify the flow level below 3,600 cfs that bears the least impact and reduce its release from Thurmond Dam to that level. (5) The water users should identify ways (e.g. local engineering measures) of avoiding or mitigating impacts of such flow reduction and communicate such measures as well as the costs of such measures to the Corps and the States.

Proposed Hydrologic Conditions for Evaluation

On an annual basis, the total amount of inflow to the Savannah System (defined as the Savannah River reservoir system operated by the Army Corps of Engineers) was lowest in 1988, averaging only 3,286 cfs. The second lowest year was 2007, with an average inflow of 3,302 cfs. Based on a long-term average annual inflow of 7,852 cfs, the amounts of inflow in these two years are 42% of normal.

It is thus suggested that the hydrologic conditions of these two years be used to evaluate adverse conditions the system may experience in the rest of 2008 and the next two years. We believe it is a conservative assumption that the on-going drought (which is very close to the drought of record), after impacting for more than two years now, would repeat itself in the next three years. This basically means that after a year of 3,302 cfs inflow, inflow at this level would repeat again and again in each of the next three years.

We also suggest that variations of the 1988 and 2007 hydrology (e.g. 10% reduction in inflow) be used to evaluate potential operations of the Savannah System. We believe it is a very conservative assumption that another round of drought of record with a magnitude of 10% reduction in inflow will repeat itself in 2008, 2009, 2010, and 2011. This gives us the possible but very unlikely hydrologic scenario that after a year of 3,302 cfs inflow, we would have another two to three years in a row with inflow lower than 3,000 cfs (38% of normal).

Baseline Operations under Proposed Hydrologic Conditions

The Corps' current operation calls for a release of 3,600 cfs from Thurmond Dam. This operation's impact on the reservoirs can be assessed with the Corps' spreadsheet tool. Using this tool and the assumed hydrologic conditions, we were able to show how system conservation storage would change as a result of the baseline operation.

Fig. 1 shows the impact of the baseline operation on system conservation storage under recorded 2007 inflow and a variation of this inflow series. Under 2007 hydrology,

system storage will continue to decline to dangerously low levels toward the end of 2008, with only 18% of conservation storage remaining in Hartwell, Russell, and Thurmond. System conservation storage will recover somewhat in early 2009, but start declining again in April 2009 and reach 15% late 2009.

Under the hydrologic scenario with a 10% reduction in inflow, the system will fare even worse. There will be about 16% of system conservation storage left by the end of 2008, and only 3% remaining by the end of 2009. The conservation pool would be virtually empty at this point. The conservation pool will be completely exhausted by November 2010.

Fig. 2 shows the impact of the baseline operation on system conservation storage under another record dry year with a different precipitation pattern, year 1988. Under this hydrology, system conservation storage will see a less dramatic decline in the summer and fall seasons, but also with a less pronounced recovery in the following winter and spring. Overall, there will be a declining trend.

Under the reduced 1988 inflow scenario, system storage will reach 10% by the end of 2009, and be completely exhausted by October 2010.

It is apparent that if the current drought persists at its current intensity or if it intensifies, the baseline operation is not enough to stabilize conservation storage, let alone refilling the system. For the benefit of all stakeholders in the basin, more needs to be done to stop the loss of conservation storage in the middle of this drought.

Critical Flow Requirements

Prior work done by Georgia and South Carolina resource agencies and the federal government provided critical elevations for most withdrawing facilities along the main stem of the Savannah River downstream of Thurmond Dam. This information is provided in Table 1.

Based on rating curves provided by Georgia EPD's Savannah River water quality model, we were able to calculate flow rates that correspond to these minimum elevations. The flow rates are also provided in Table 1.

From this exercise, it is clear to us that the likely controlling flow rates are those at Savannah Electric-Plant McIntosh and Georgia Pacific. The minimum desired flow rate at the intake of Savannah Electric-Plant McIntosh is calculated to be 3,500 cfs. The minimum desired flow at the intake of Georgia Pacific is calculated to be 3,300 cfs. However, since surface elevation in the river at these two facilities is under tidal influence, which may nullify the effects of low stream flow in the river, this tidal influence may help ease the concern that potential reduction in Thurmond release would impact the facilities' intake.

Since flows desired at the locations of the other facilities are much lower than what is needed to sustain water access at these two facilities, we believe these flow rates should serve as the basis for the computation of any potential relief of flow requirement at Thurmond Dam.

Another factor to consider is that there exists substantial amount of incremental flow between Thurmond Dam and the intakes of either Savannah Electric-Plant McIntosh or Georgia Pacific. A flow at the locations of these facilities is the result of Thurmond release supplemented by incremental flow between Thurmond and the concerned location.

Recorded Incremental Flow

If the Corps considers potential relief from the 3,600 cfs minimum release requirement from Thurmond, then it is critically important to determine the amount of incremental flow between Thurmond and the locations of the controlling facilities. Since the closest USGS gauge to the two controlling facilities, Savannah Electric-Plant McIntosh and Georgia Pacific, is Savannah River near Clio, Georgia (02198500), we need to use the incremental flow between Thurmond and the Clio gauge to estimate the amount of incremental flow. Also, since the Clio gauge is upstream of these two facilities, the entire amount of incremental between Thurmond Dam and the Clio gauge can be applied to both facilities.

Using release data from Thurmond (Corps) and gauged stream flow data at the Clio gauge (USGS), we were able to derive incremental flow between these two locations. For the purpose of smoothing out the impact of routing and travel time, we applied a 7-day moving average for both variables.

As shown in Fig. 3, the magnitude of incremental flow between Thurmond and the Clio gauge stayed above 500 cfs for most of 2007, with the exception of a few days in November 2007, when it dropped to around 300 cfs. For the previous drought of record, year 1988, the incremental flow between these two locations remained higher than 800 cfs (See Fig. 4).

As the U.S. Drought Monitor (Figs. 5 and 6) indicate that the lower Savannah River Basin is in better shape compared to the worst time in last year, when the incremental flow was the lowest in November 2007, and the fact that the coastal area may benefit from ocean-originated precipitation in the summer and fall, it is reasonable to assume that the incremental flow between Thurmond and Clio this year will not be at a level worse than in 2007. In other words, it is not unreasonable for us to expect at least 300 cfs to 500 cfs of incremental flow between Thurmond and the Clio gauge.

Proposed Relief from Thurmond Minimum Flow Requirement

We use the most severe hydrologic conditions suggested earlier in this document to evaluate the contemplated alternative operations of the Savannah System. These

conditions are recorded 2007 inflow with a 10% reduction and recorded 1988 inflow with a 10% reduction. A repetition of such conditions, after two years of record-breaking drought, for the next three or four years, in our opinion, provides enough of a challenge to the entire system. Table 2 provides a summary of all the simulations.

Based on the estimated minimum incremental flow of 300 cfs to 500 cfs, we can use a Thurmond release of 3,300 cfs and 3,100 cfs to test the impact to the reservoir system and the downstream river. It is reasonable to assume that at these levels of Thurmond release, the needs of the other stakeholders are met (Table 1).

We first tested a flat release from Thurmond Dam of 3,300 cfs and 3,100 cfs with both hydrologic conditions. Table 2 provides a summary of the hydrologic conditions and alternative operations in the tested scenarios. The resulting reservoir conservation storage change is shown in Figs. 7 and 8.

Under the recorded 2007 hydrology (with a 10% reduction in inflow), a release of 3,300 cfs from Thurmond Dam will not be enough to stabilize the reservoir system. There will be a sharp decline of system conservation storage, resulting in a low system storage at 20% toward the end of 2008. Storage will recover somewhat during the winter and spring period of 2009, but will start to decline again and reach a new low (16%) toward the end of 2009. If hydrologic conditions do not improve dramatically, this downward trend will continue, and the low system storage will keep declining year after year (Fig. 7).

If release at Thurmond Dam is reduced to 3,100 cfs, however, the trend of decline will be stopped. The system storage will still go up and down seasonally, but the declining trend under the 3,300 cfs release will cease to exist.

Under the recorded 1988 hydrology (with a 10% reduction in inflow), the seasonal decline in the summer and fall will be less dramatic than under the 2007 inflow, however, there will be less of a recovery in the following rainy season (Fig. 8). Under a 3,300 cfs Thurmond release, system storage will reach 34% by the end of 2008 and around 24% toward the end of 2009. This moderate reduction in Thurmond release is far from enough to stop the sharp declining trend in system storage.

If release at Thurmond Dam is at 3,100 cfs level, the overall declining trend will still exist. However, the rate of decline of system conservation storage will be much more moderate compared to the rate of decline under a release of 3,600 cfs (baseline) or 3,300 cfs (Fig. 8).

We understand that a full-scale deviation from the minimum release of 3,600 cfs may require the Corps to go through the NEPA process and to conduct an Environmental Impact Study, which may take years to complete and cause the loss of opportunity to slow the decline of system storage. We also understand that a seasonal deviation (e.g. a reduced release from Thurmond Dam in the cooler seasons) may be easier to achieve, since an Environmental Assessment may suffice in this case.

Thus, we tested an operation scenario where release from Thurmond will be kept at 3,600 cfs for the months of March through September and reduced to 3,100 cfs for the cooler seasons (October through February). The resulting conservation storage percentage (under both 2007 and 1988 inflow with a 10% reduction) is shown in Fig. 9. It can be seen that system conservation storage will remain available at least throughout the next three years. With such adverse hydrologic conditions, system storage will continue to decline, but at a comparatively slow rate.

Under this operation scheme, even if record-breaking drought conditions continue during the next three years, there will be enough conservation storage to support the revised Thurmond release, and the Corps will have enough time to make further revision of its operations in response to persistent or deteriorating conditions.

We make the recommendation that the Corps adopt this operation scheme.

Impacts to Lake and River Water Users

The suggested operation will not be any different from the current baseline operation in the months between March and September, and should not have any impact on water supply intakes throughout the basin during this time period.

In the cooler seasons when Thurmond release is reduced to 3,100 cfs, the most likely impact, based on information in Table 1 and earlier analysis, will be felt by facilities downstream of Thurmond Dam. These facilities include Savannah Electric-Plant McIntosh and Georgia Pacific. Because the proposed operation will not deplete system conservation storage, water users whose intakes are located in the pools of Hartwell, Russell, and Thurmond will not be affected.

Flow at the locations of Georgia Pacific can be determined by Thurmond release with the addition of incremental flow between Thurmond and the Georgia Pacific intake, which is estimated to be around 500 cfs at the driest times, except for a few days, when it may be as low as 300 cfs. This will result in the lower flow at the Georgia Pacific intake to be at 3,600 cfs generally, and at 3,400 cfs at the lowest level. Given that the facility intake will function at flows higher than 3,300 cfs, it is expected that the proposed revision in operation will not have any impact to this facility.

Flow at the intake of Savannah Electric-Plant McIntosh can also be determined similarly. The proposed operation may result in an at-site flow of 3,400 cfs to 3,600 cfs at the intake of Plant McIntosh. Table 1 shows that the intake at Plant McIntosh functions at the minimum flow of 3,500 cfs. So, if the lowest incremental flow (recorded in 2007) were to take place again this year, the intake at this facility may not function well in the short period of a few days when the at-site flow is as low as 3,400 cfs. However, since water surface elevation at this facility's intake is under tidal influence, any impact resulting from reduced Thurmond release may be nullified.

Also, there are measures that can be taken to mitigate the impact. First, drought-proof engineering measures can be taken to either deepen the bottom elevation at the intake or to elevate the water surface elevation. The Corps may be able to help such measures through federal emergency programs. In fact, we encourage all water users in the basin to consider local measures that can make water supply more secure.

Second, adaptive management can be put in place to monitor the elevation at this facility to make sure that sufficient flow takes place when incremental flow is not enough.

There may also be concern from water users along the Augusta Canal. However, by our estimate, at a Thurmond release of 3,100 cfs during the cooler seasons, there will be roughly 1,000 cfs flowing through the shoals and 2,100 cfs flowing in the Canal. This is more than the stated 1,600 cfs needed to operate the facilities along the Canal.

Impact to Water Quality

To assess the potential impact on water quality of the proposed operation, Georgia EPD, in coordination with SCDHEC and SCDNR, has performed water quality (dissolved oxygen - DO) modeling of both the Savannah River downstream of Thurmond Dam and the Savannah Harbor. The modeling results indicate that the seasonal reduction of Thurmond release would not cause water quality problems in the river or the harbor.

1. Savannah River downstream of Thurmond Dam

The first model simulation has been conducted with 2007 meteorological data, 2007 tributary inflows, 2007 Thurmond release data, and waste load discharges and water withdrawals as recorded in 2006. This run was performed to see how well the model is calibrated to observed DO data. Figs. 10 and 11 show the observed DO data (red squares) measured in 2007, which never went below 6.5 mg/L and 6.29 mg/L at River Mile (RM) 119 and RM 61, respectively, versus the approximate calibration run. It is an approximate calibration run since the model did not include 2007 discharge and withdrawal data, but rather that of 2006. Despite the approximation of this model run, the results indicate that the model has been calibrated relatively well.

Second and third model simulations were conducted with 2007 meteorological data, 2007 tributary inflows, and waste load discharges and water withdrawals as recorded in 2006. However, these model scenarios incorporated Thurmond releases of 3,600 and 3,100 cfs.

Figs. 12 and 13 show the results of the 3,600 cfs simulation. Under a Thurmond release of 3,600 cfs, the simulated DO concentrations at RM 119 were predicted to be above 5 mg/L throughout the year (Fig. 12). Fig. 13 shows simulated DO concentration at River Mile 61 under a Thurmond release of 3,600 cfs. Again, the simulated DO concentrations were predicted to be higher than 5 mg/L throughout the year. The water quality model shows that the 5.0 mg/L DO standard would not be breached by a Thurmond release of 3,600 cfs.

Figs. 14 and 15 show the simulated DO concentrations at River Mile 119 and River Mile 61 respectively, under a Thurmond release of 3,100 cfs. Even though we do not propose a reduction of Thurmond release in the summer time, our model indicated that there would not be a DO problem throughout the year. For the cooler months from October to February, DO concentration would always be higher than 6.0 mg/L and almost always higher than 7.0 mg/L at both River Mile 119 and River Mile 61.

We need to point out that the water quality model used in this analysis does not contain any modules simulating algal activity in the river. This lack of simulated algal activity means that our model tends to give overly pessimistic DO concentrations. It is highly likely that field data will provide higher DO concentrations than the model predicted.

The proposed action includes a continuation of 3,600 cfs release from Thurmond Dam in the months of March through September and a 3,100 cfs reduced release from Thurmond Dam in the cooler seasons (October through February). This action will not result in any adverse change in DO concentration in the warmer months. We suggest that monitoring stations be set up at locations along the river to monitor the change of DO concentration along the lower reaches, if the proposed operation is adopted. We also suggest that adaptive management be used as part of the Corps' operation. If field observation indicate any problem with DO concentration, then prompt actions can be taken to mitigate the adverse conditions.

2. Savannah Harbor

Two water quality related effects of lower Savannah River streamflows resulting from reduced Thurmond Reservoir releases were assessed. These were elevated chloride concentrations at the City of Savannah municipal water intake on Abercorn Creek, and dissolved oxygen concentrations in the Harbor.

The City of Savannah's municipal water intake is located on Abercorn Creek approximately two miles from the Savannah River. The City of Savannah is concerned about distributing water to its customers, particularly industries, when chloride concentrations in Abercorn Creek are greater than 12 milligrams per liter (mg/L). Such concentrations have been shown to cause scaling in boilers.

Sources of chloride in Abercorn Creek are upstream inflows from the Savannah River, and salinity intrusion from the downstream Savannah Harbor estuary. Studies have shown a good relationship between River flows at the U.S. Geological Survey's Clio, Georgia stream gage location and chloride concentrations. Results have shown that the Savannah River contains approximately 10 mg/L of chloride during low flows, and 4 mg/L during high flows as a result of greater dilution. Therefore, it is during low flow periods where River chloride concentrations are as high as 10 mg/L when salinity intrusion from downstream can cause an additional 2-4 mg/L in the vicinity of the intake and exceed the 12 mg/L threshold. Analysis of the historical chloride data collected at the City's intake shows that during drought years the number of samples with chlorides

exceeding 12 mg/L ranges from 21 to 58 percent, and concentrations have approached 19 mg/L.

Lowering releases from Thurmond Reservoir, by itself, does not create higher chloride concentrations at the City of Savannah's water withdrawal. Rather, it is the combination of low releases from Thurmond Reservoir and low streamflows from the downstream watershed that create a condition for elevated chloride concentrations at the City's withdrawal. Therefore, the proposed reservoir operation schedule will not improve conditions for chloride concentrations at the City's intake, and with sufficient downstream inflows these conditions should remain unchanged. However, given the existing sensitivity of the City's intake to chloride concentrations greater than 12 mg/L as shown by the historical exceedances of this threshold, proposed reservoir operation combined with low downstream inflows might increase the number and magnitude of chloride concentrations greater than 12 mg/L at the City of Savannah municipal water withdrawal. Therefore, it is recommended that Savannah River flows at Clyo and chloride concentrations at the City's water intake be monitored closely to assess the effects of reservoir operation.

The effect of the proposed Thurmond reservoir operation on dissolved oxygen concentrations in Savannah Harbor was evaluated using the Savannah Harbor Model. Savannah River Model streamflow and water quality results provided input for the upstream boundary of the Savannah Harbor Model. Model results and the effects on dissolved oxygen concentrations were evaluated at the U.S. Army Corps of Engineers' dock located in the Harbor. The results were compared to the existing coastal fishing classification whose dissolved oxygen criteria is no less than 3.0 mg/L during June through October, no less than 3.5 mg/L in May and November, and no less than 4.0 mg/L during December through April. The results are shown in Figure 16. With respect to Dissolved Oxygen Standards applicable to the Harbor, at the present time, the Savannah Harbor is under a Total Minimum Daily Load for Georgia which indicates 0 assimilative capacity available for the NPDES permitted wastewater treatment system dischargers. The TMDL is based on a 1989 Georgia seasonal Dissolved Oxygen standard which was never approved by the EPA. The GAEPD is in the process of revising the Harbor DO standard which will provide some assimilative capacity for the dischargers, and be similar and consistent with the South Carolina DO standard. Harbor dissolved oxygen monitoring will continue and impact to harbor dissolved oxygen attributable to seasonal dam releases will be evaluated and those operations modified as appropriate.

Other Potential Impacts

Since a seasonal deviation from the 3,600 cfs Thurmond release does not constitute a significant change in operations of the system, we do not foresee any impacts on other aspects and other water users of the Savannah River Basin.

We are willing to work with other resource agencies to address such concerns, if additional stakeholder groups raise concerns. We believe technical tools, such as WASP

model and other models exist and are available for use to address salinity, temperature, and other issues.

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Table 1. Major facilities along the main stem Savannah River and their tolerance of low elevations and flow rates

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FACILITY NAME	INVERT ELEVATION (FT-MSL)	MINIMUM ELEVATION (FT-MSL)	NOTES	CORRESPONDING FLOW TO MIN ELEV. (CFS)
Columbia County			Their withdrawal is upstream from the Stevens Creek Dam.	
Augusta Canal			The necessary flow to support the municipal water withdrawal is 600-800 cfs. There is a deisel back-up pump but it is not capable of providing the full supply requirement. At some flow rate the downstream electric generation will be halted.	~1600 cfs in the Canal + 1000 cfs in shoal
Edgefield County	149.50	149.50	1989 Drought Plan. This value was confirmed by SCDHEC.	
City of Augusta		119.5		
City of North Augusta	106.00	109.00	Minimum elevation value came from the New Savannah Bluff Lock and Dam Project Disposition Report.	1000 cfs at elevation 109 ft
South Carolina Electric and Gas	106.00	105.50	Minimum elevation value came from the New Savannah Bluff Lock and Dam Project Disposition Report.	900 cfs at elevation 106 ft
PCS Nitrogen	97.75	103.90	PCS Nitrogen and DSM Chemical share the same intake structure. A minimum elevation value of 110 came from the New Savannah Bluff Lock and Dam Project Disposition Report. Actual numbers came from a contact with PCS Nitrogen.	1300 cfs at elevation 110 ft
DSM Chemicals	97.75	103.90	PCS Nitrogen and DSM Chemical share the same intake structure. A minimum elevation value of 110 came from the New Savannah Bluff Lock and Dam Project Disposition Report. Actual numbers came from a contact with PCS Nitrogen.	1300 cfs at elevation 110 ft
General Chemical	110.20	111.00	Minimum elevation value came from the New Savannah Bluff Lock and Dam Project Disposition Report.	1800 cfs at elevation 111 ft at DSM Chemical
Kimberly Clark		109.00	Minimum elevation value came from the New Savannah Bluff Lock and Dam Project Disposition Report.	1060 cfs at elevation 109 ft
International Paper	94.00	94.00		2800 cfs at elevation 94 ft
Savannah River Site	81.00	81.00	Latest information indicates that 79 ft is sufficient	3400 cfs at elevation 81 ft, 2300 cfs at elevation 79 ft
Plant Vogtle	70.00	70.00		always met
Savannah Electric-Plant McIntosh	7.50	7.50		3500 cfs at elevation 7.5 ft

Georgia Pacific	-1.00	5.16	<p>Georgia Pacific stated that their minimum operational level is equivalent to a gage height of 2.0 feet at Clio. Since the gage datum at Clio is 13.39 feet-msl this results in a minimum elevation at Clio of 15.39 feet-msl which is equivalent to a Savannah River flow of 3300 cfs. This corresponds to a water surface elevation of 5.16 ft-msl at the Georgia Pacific withdrawal.</p>	3300 cfs per note
City of Savannah		-10.22		
Beaufort-Jasper		-3.0		

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Table 2 Simulated hydrologic and operational scenarios

Scenario	A: Recorded 2007 Inflow	B: 2007 Inflow * 90%	C: Recorded 1988 Inflow	D: 1988 Inflow * 90%	B3300: Thurmond release of 3300 cfs	B3100: Thurmond release of 3100 cfs	D3300: Thurmond release of 3300 cfs	D3100: Thurmond release of 3100 cfs	B: 2007 Inflow Seasonal 3100	D: 1988 Inflow Seasonal 3100
Hydrology (Inflow to reservoir system)	Recorded 2007 inflow	Recorded 2007 inflow with a 10% reduction	Recorded 1988 inflow	Recorded 1988 inflow with a 10% reduction	Recorded 2007 inflow with a 10% reduction	Recorded 2007 inflow with a 10% reduction	Recorded 1988 inflow with a 10% reduction	Recorded 1988 inflow with a 10% reduction	Recorded 2007 inflow with a 10% reduction	Recorded 1988 inflow with a 10% reduction
Operation	Thurmond release of 3600 cfs	Thurmond release of 3600 cfs	Thurmond release of 3600 cfs	Thurmond release of 3600 cfs	Thurmond release of 3300 cfs	Thurmond release of 3100 cfs	Thurmond release of 3300 cfs	Thurmond release of 3100 cfs	Thurmond release of 3100 cfs in warmer months, and 3100 cfs in cooler months	Thurmond release of 3600 cfs in warmer months, and 3100 cfs in cooler months

Savannah System Storage Change with 2007 Inflow

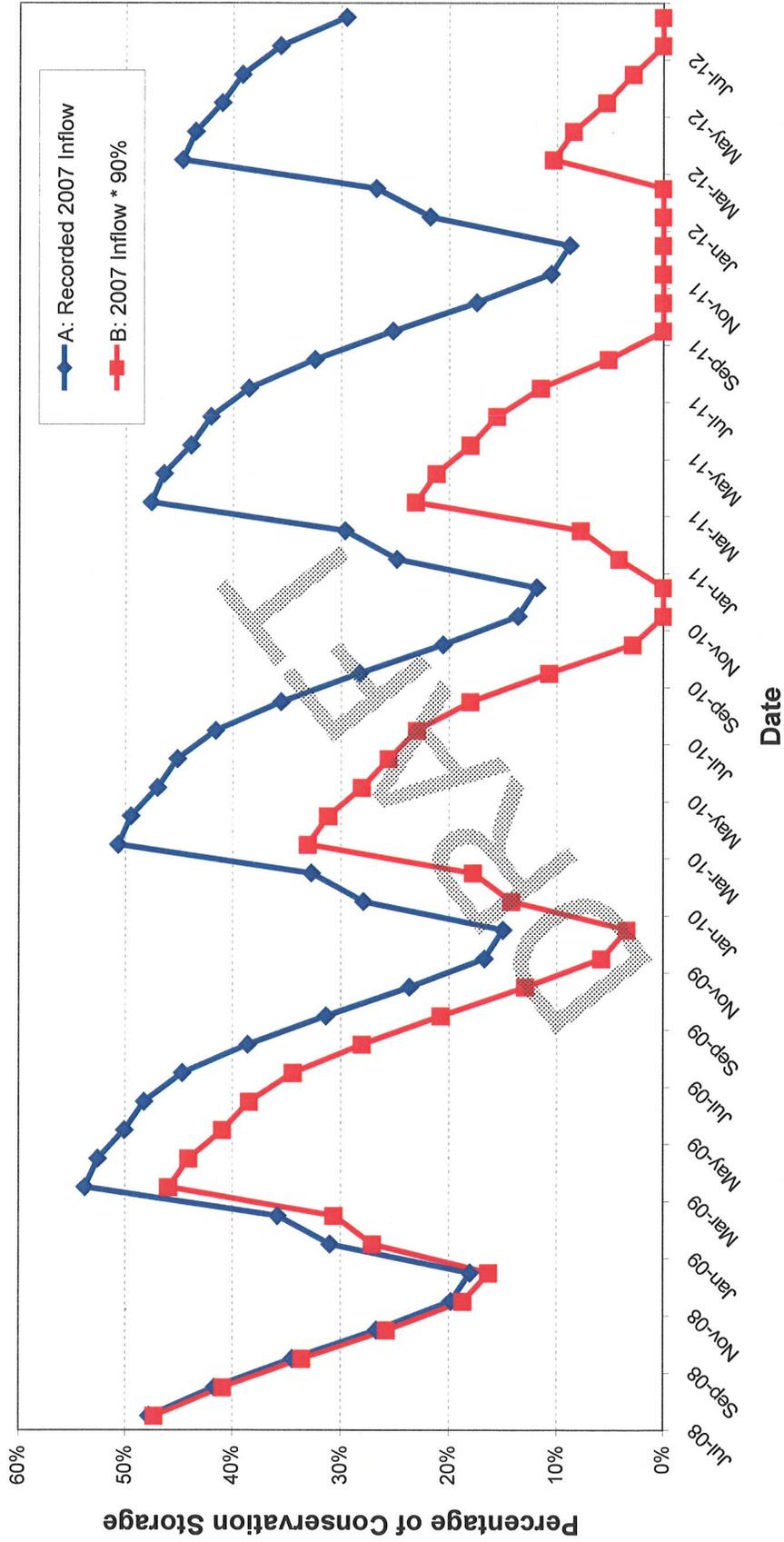


Fig. 1 Change of system conservation storage under 2007 hydrology and variation

Savannah System Storage Change with 1988 Inflow

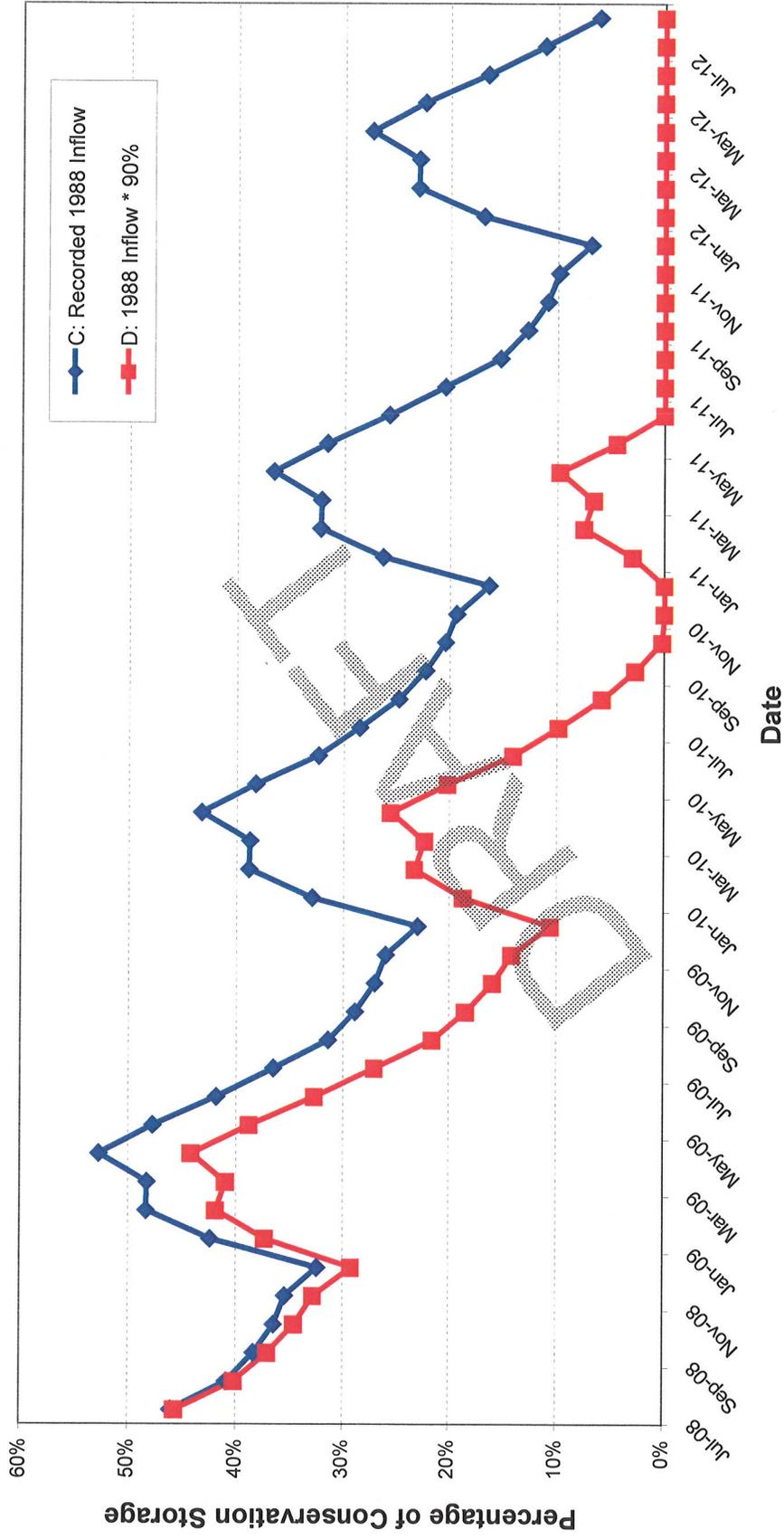


Fig. 2 Change of system conservation storage under 1988 hydrology and variation

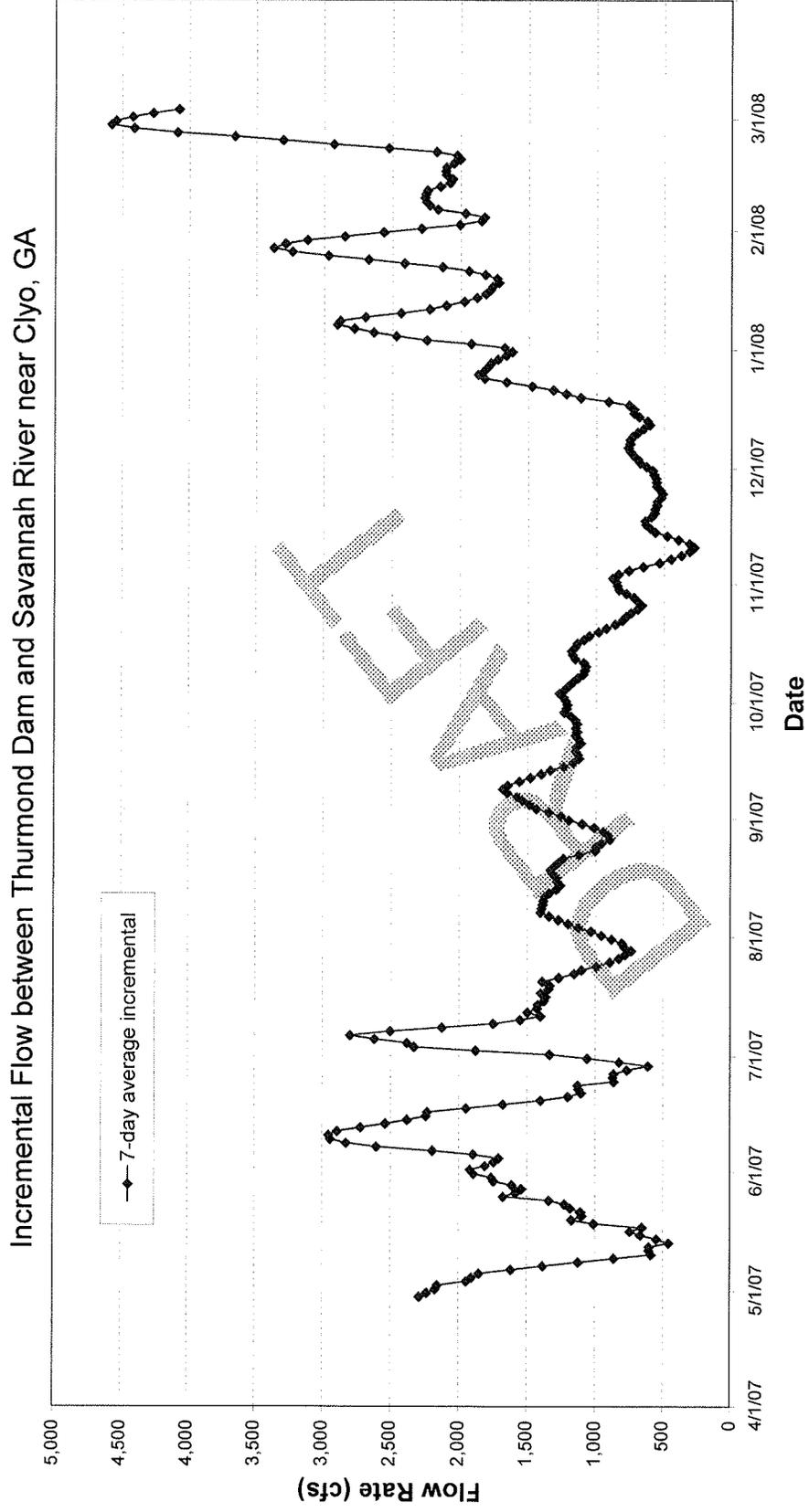


Fig. 3 Incremental flow between Thurmond Dam and USGS Clyo gage in 2007-2008 period

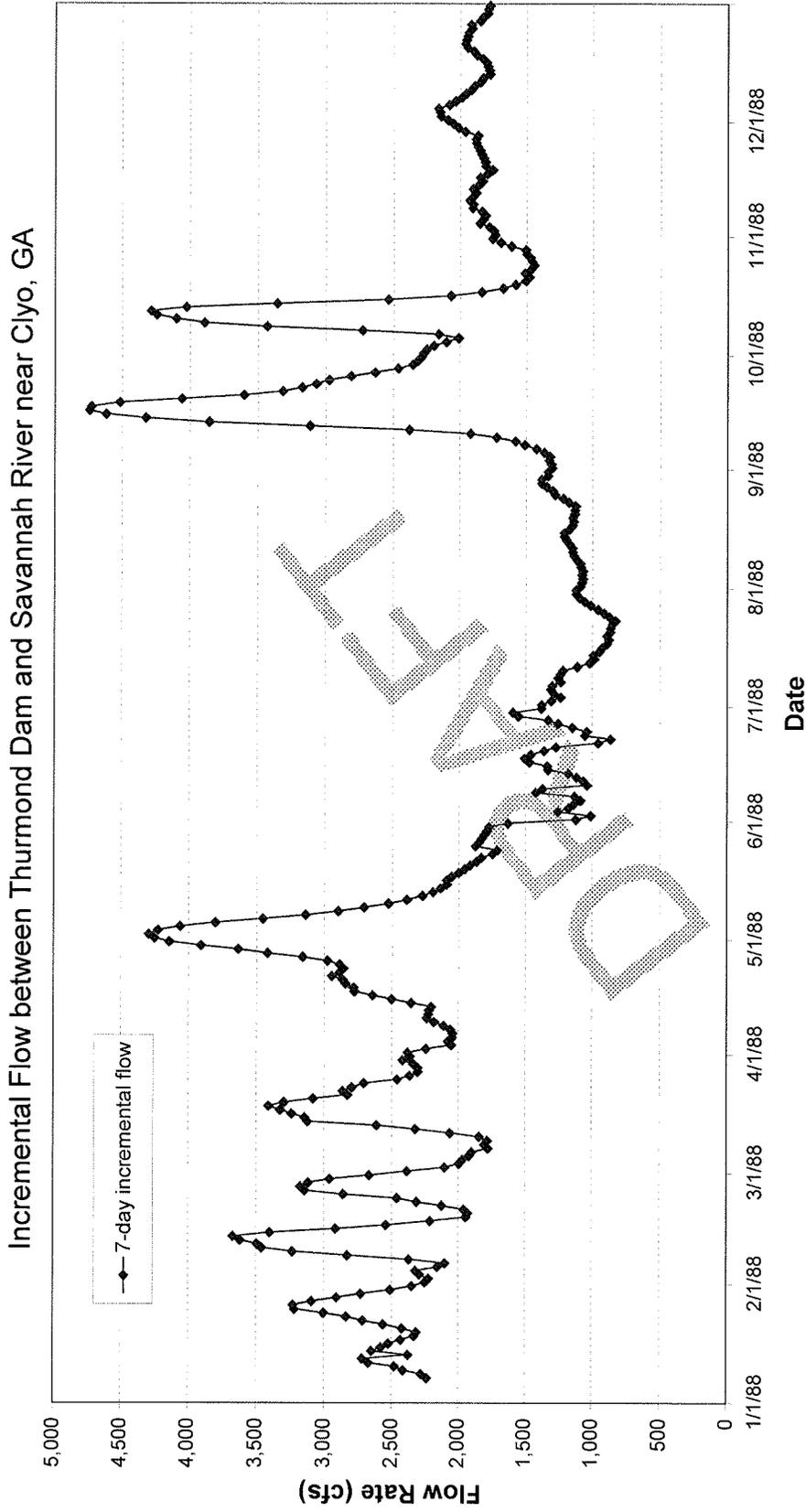
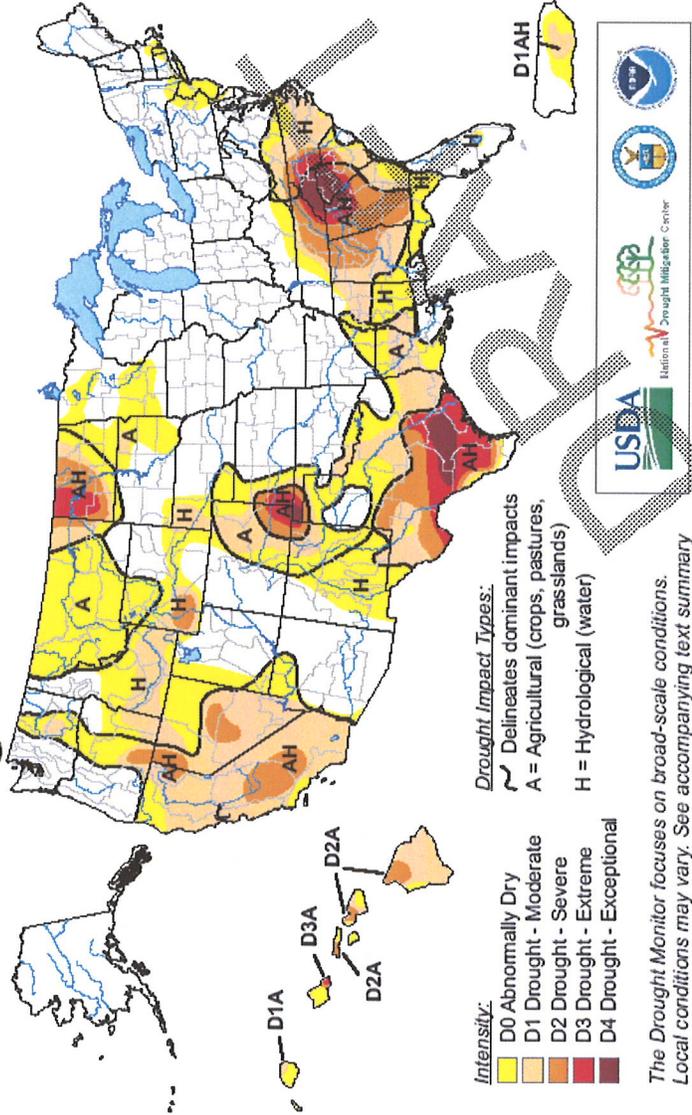


Fig. 4 Incremental flow between Thurmond Dam and the USGS Clyo gage in 1988

U.S. Drought Monitor

July 22, 2008
Valid 8 a.m. EDT



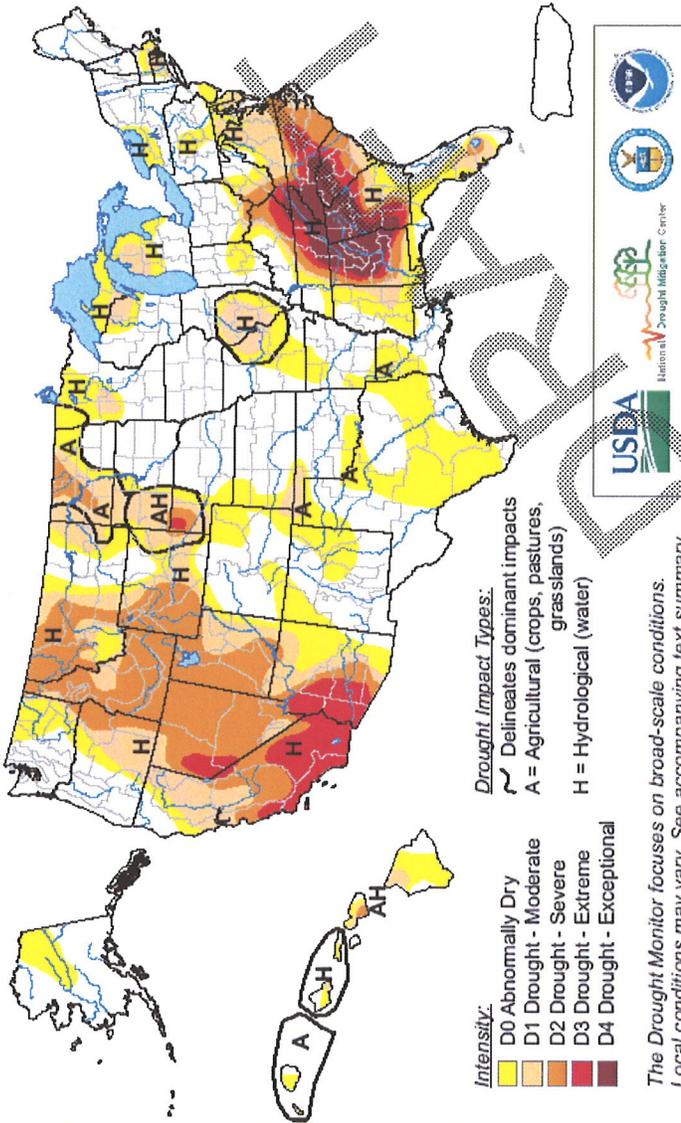
Released Thursday, July 24, 2008
Author: Brad Rippey, U.S. Department of Agriculture

Fig. 5 U.S. Drought Monitor July 2008

U.S. Drought Monitor

November 13, 2007

Valid 7 a.m. EST



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>



Released Thursday, November 15, 2007
 Author: Douglas Le Comte, CPC/NOAA

Fig. 6 U.S. Drought Monitor November 2007

Savannah System Storage Change with 2007 Inflow

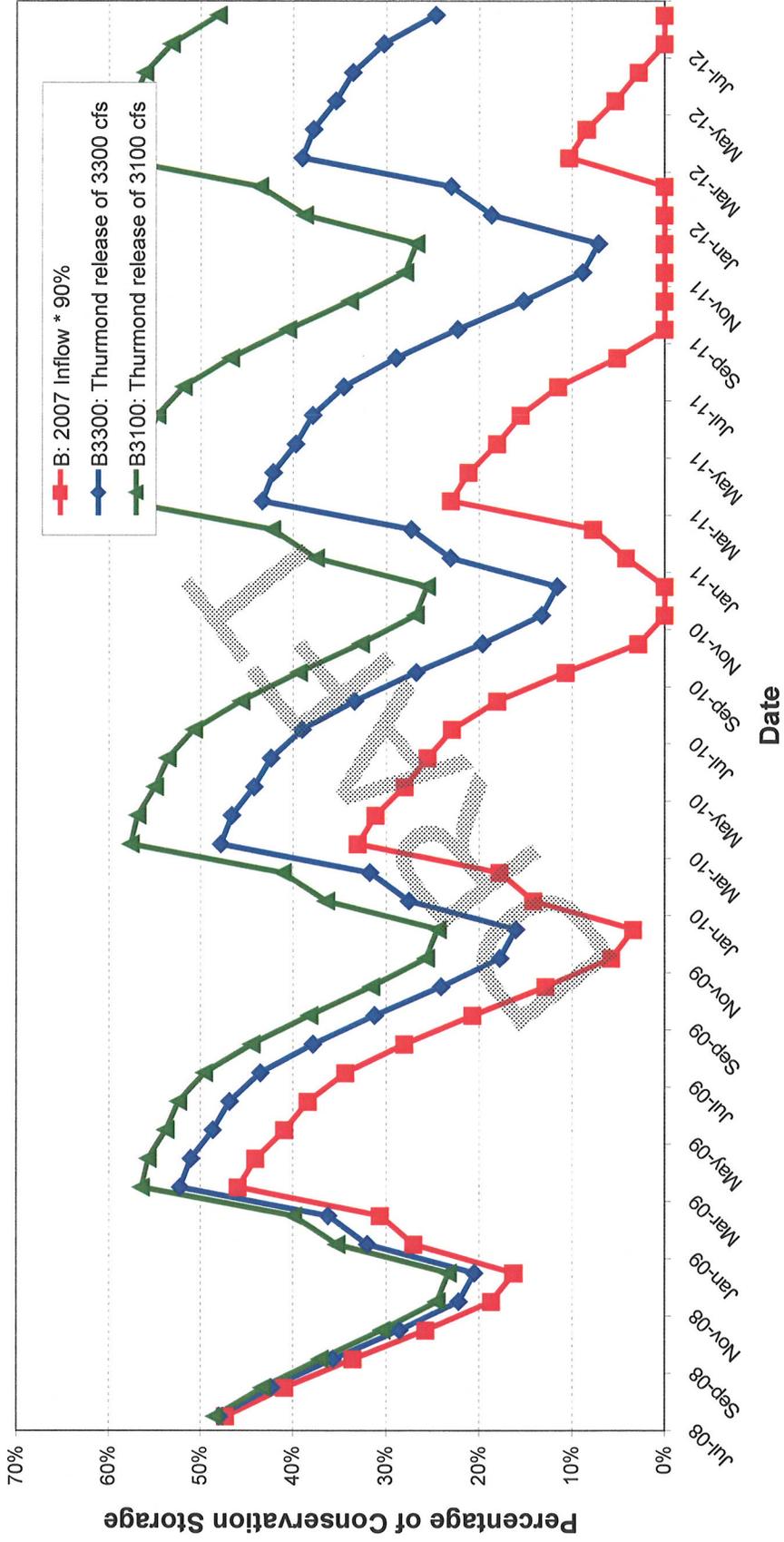


Fig. 7 Change of system conservation storage with 2007 hydrology and relief release at Thurmond

Savannah System Storage Change with 1988 Inflow

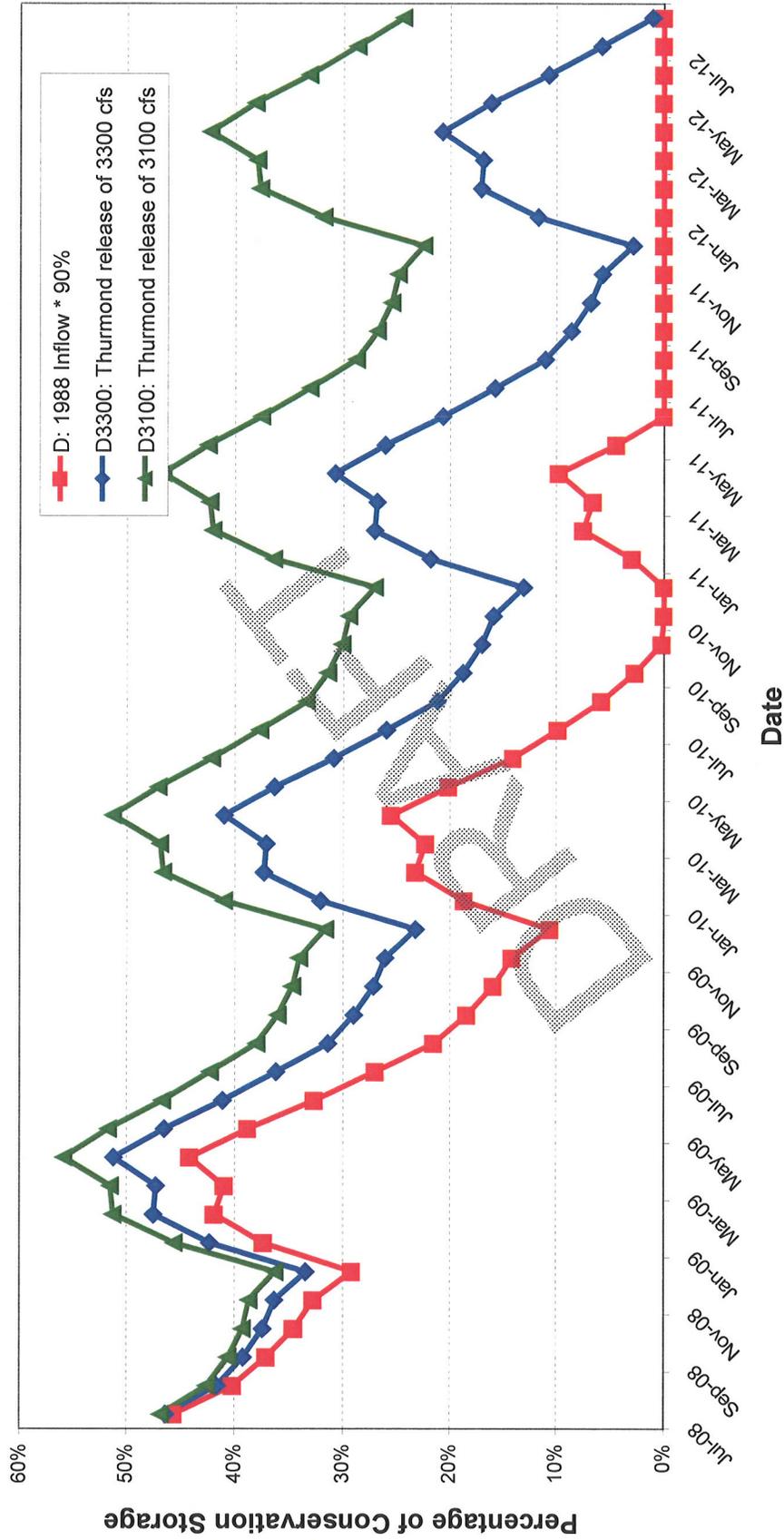


Fig. 8 Change of system conservation storage with 1988 hydrology and relief release at Thurmond

Savannah System Storage Change with Seasonal Relief

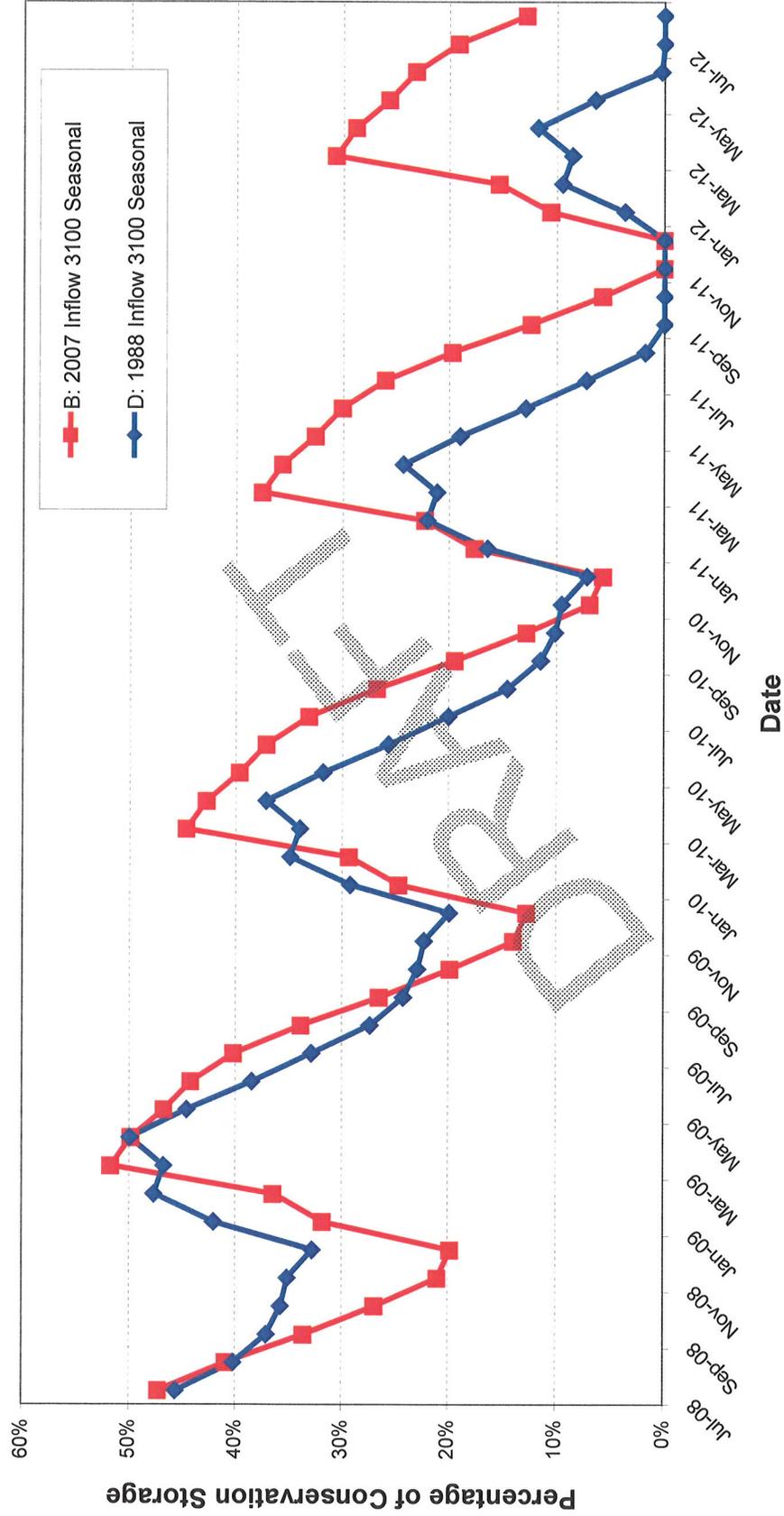


Fig. 9 Reducing Thurmond release to 3,100 cfs only in the cool season results in more stabilized system storage, even with worse-than-record inflow (90% of 2007 and 1998 recorded inflow)

Simulated and Observed Dissolved Oxygen at RM 119

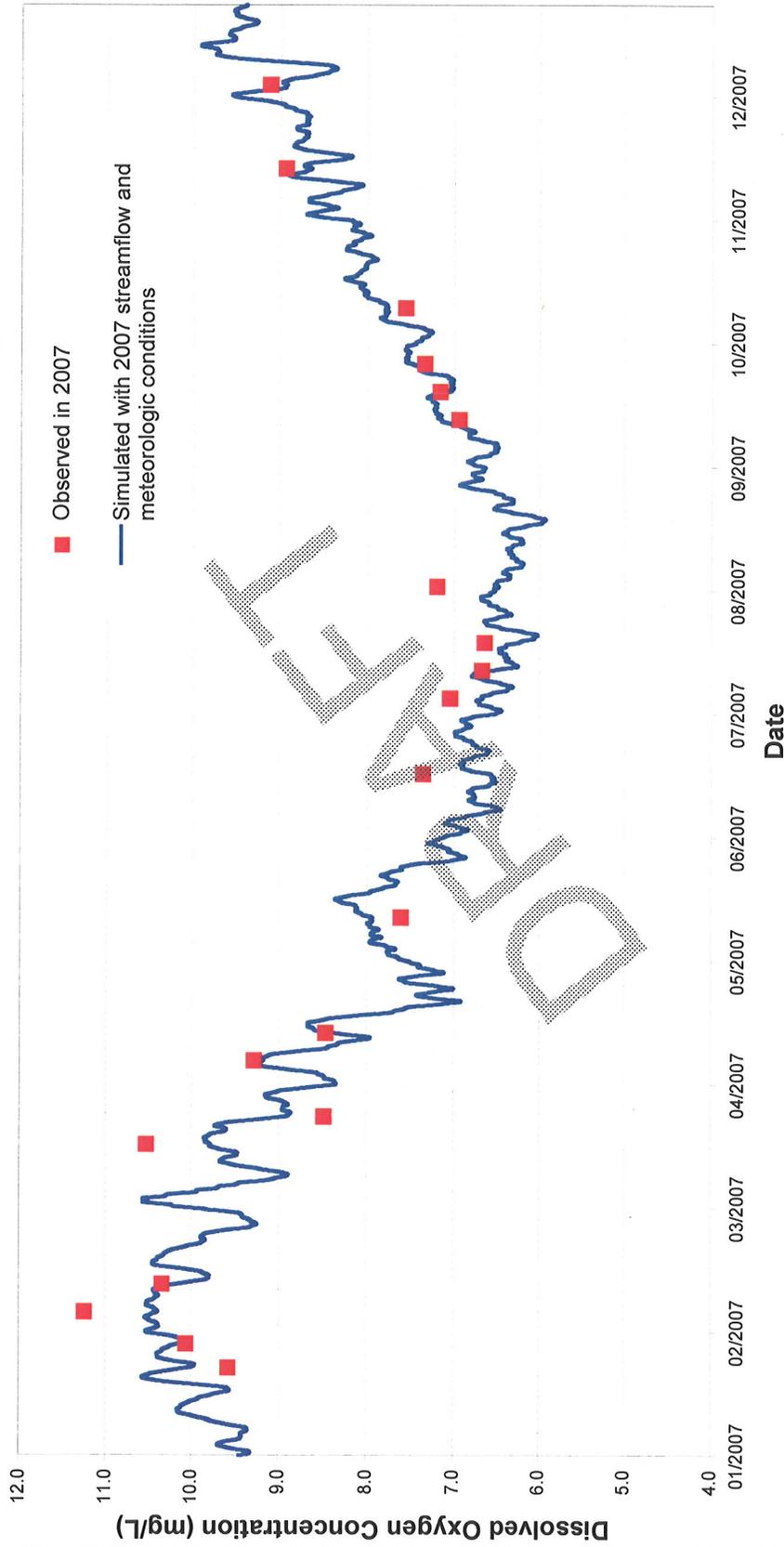


Fig. 10 Calibration of Savannah River water quality model at River Mile 119 (2007 Thurmond release)

Simulated and Observed Dissolved Oxygen at RM 61

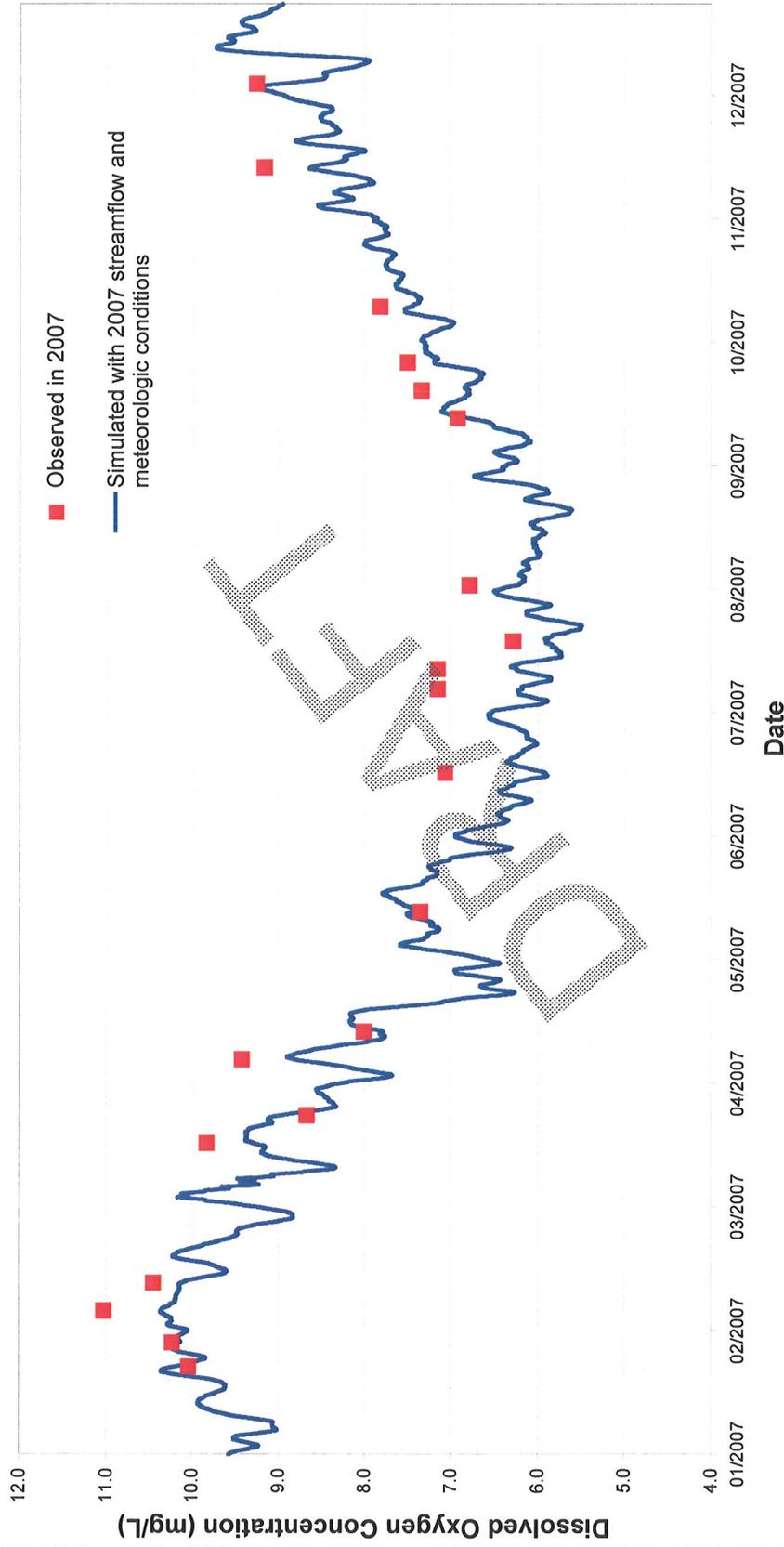


Fig. 11 Calibration of Savannah River water quality model at River Mile 61 (2007 Thurmond release)

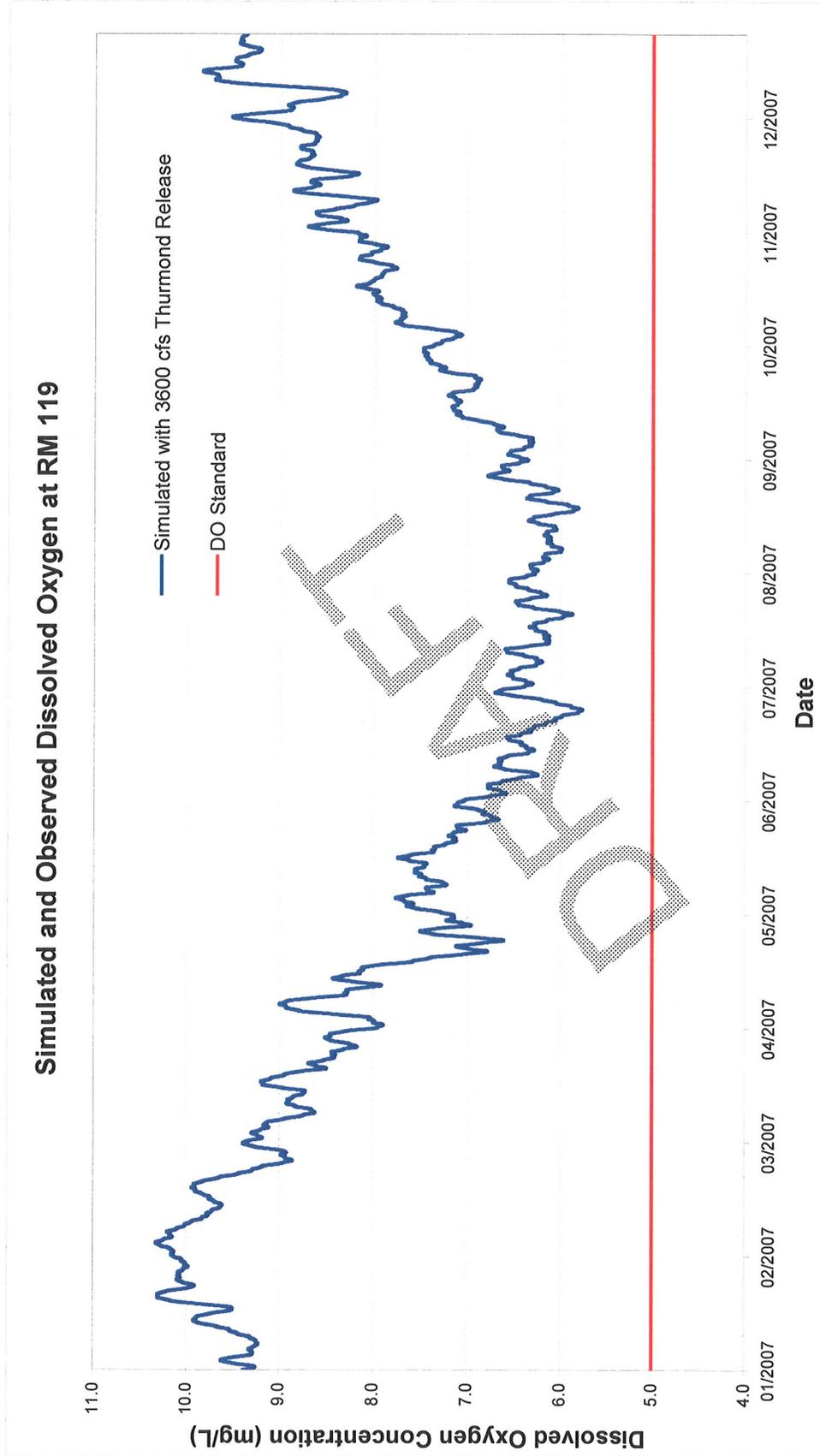


Fig. 12 Dissolved oxygen at RM 119 (with 2007 tributary inflow and meteorological data)

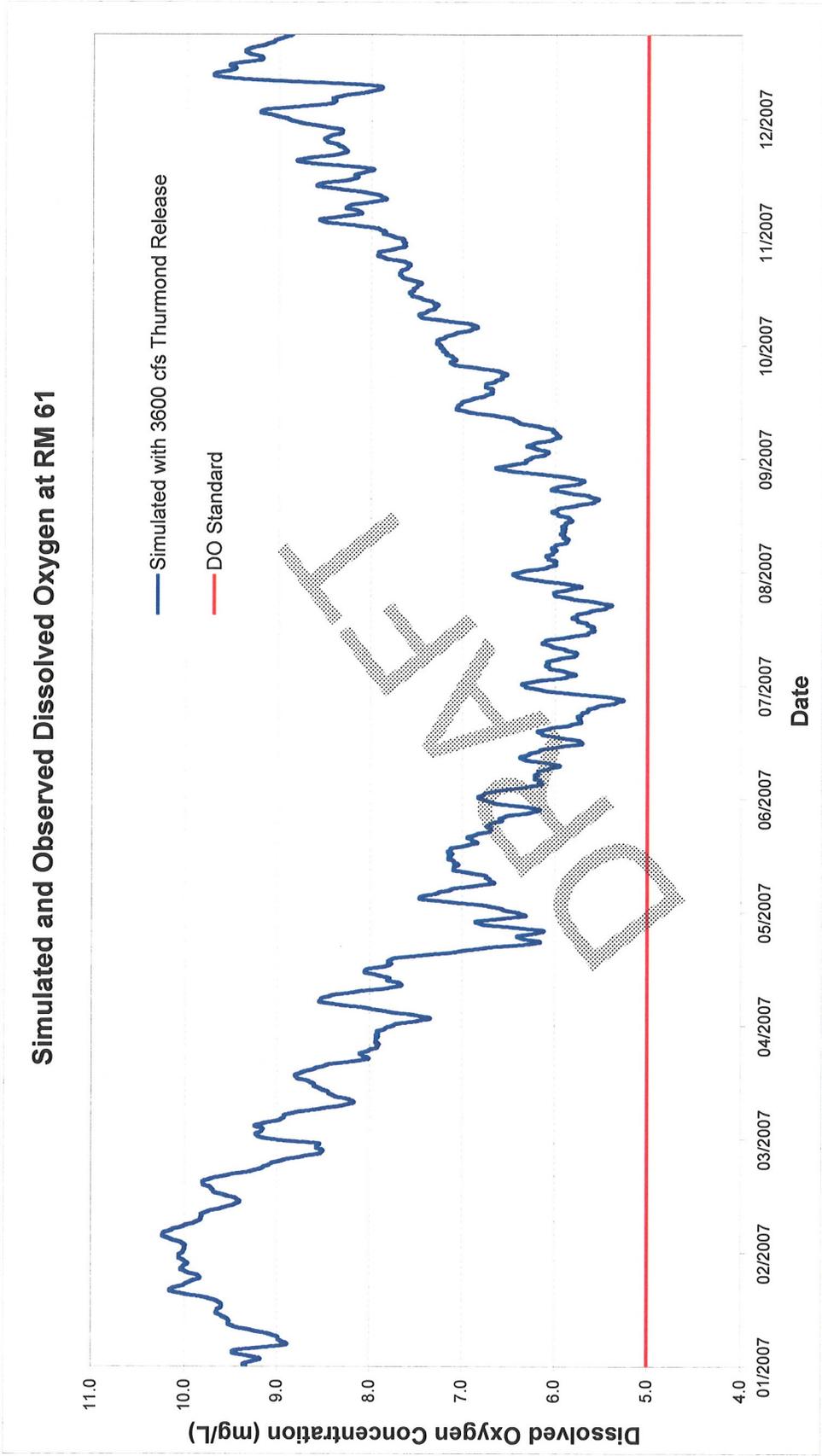


Fig. 13 Dissolved oxygen at RM 61 (with 2007 tributary inflow and meteorological data)

Simulated Dissolved Oxygen at RM 119

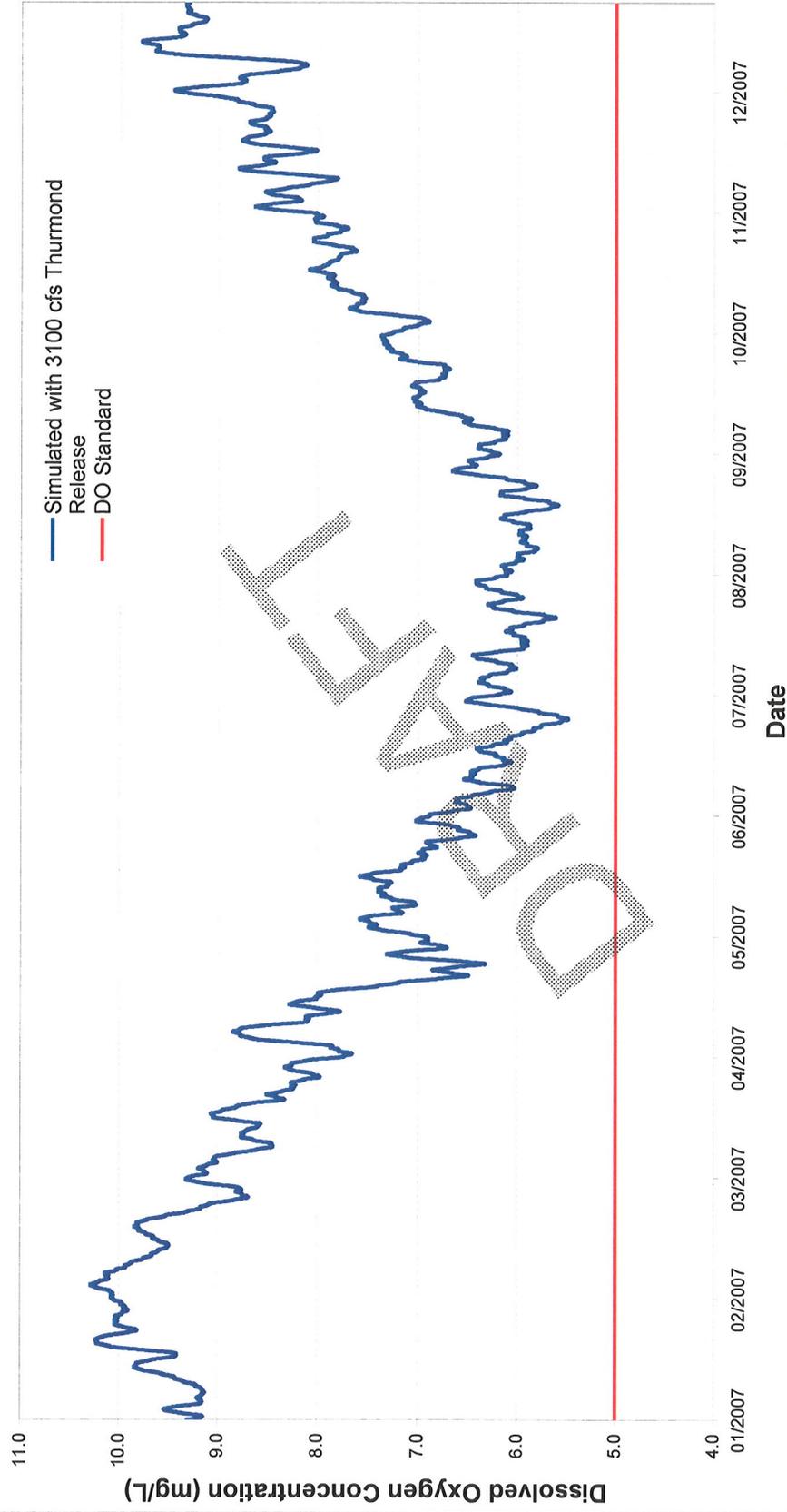


Fig. 14 Simulated dissolved oxygen at RM 119

Simulated Dissolved Oxygen at RM 61

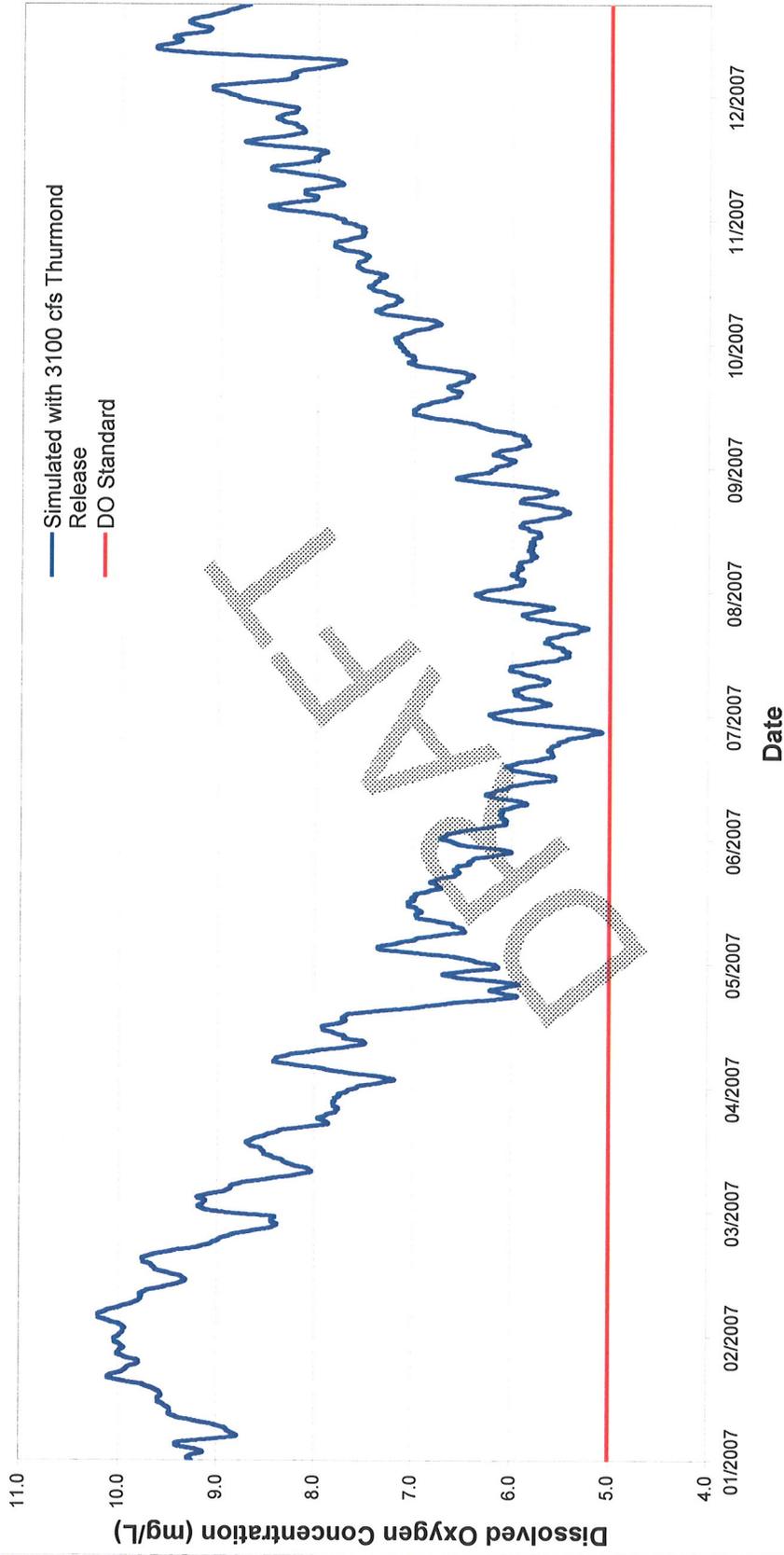


Fig. 15 Simulated dissolved oxygen at RM 61

SURFACE Dissolved Oxygen (mg/L) at the Corps Depot (FR-21)

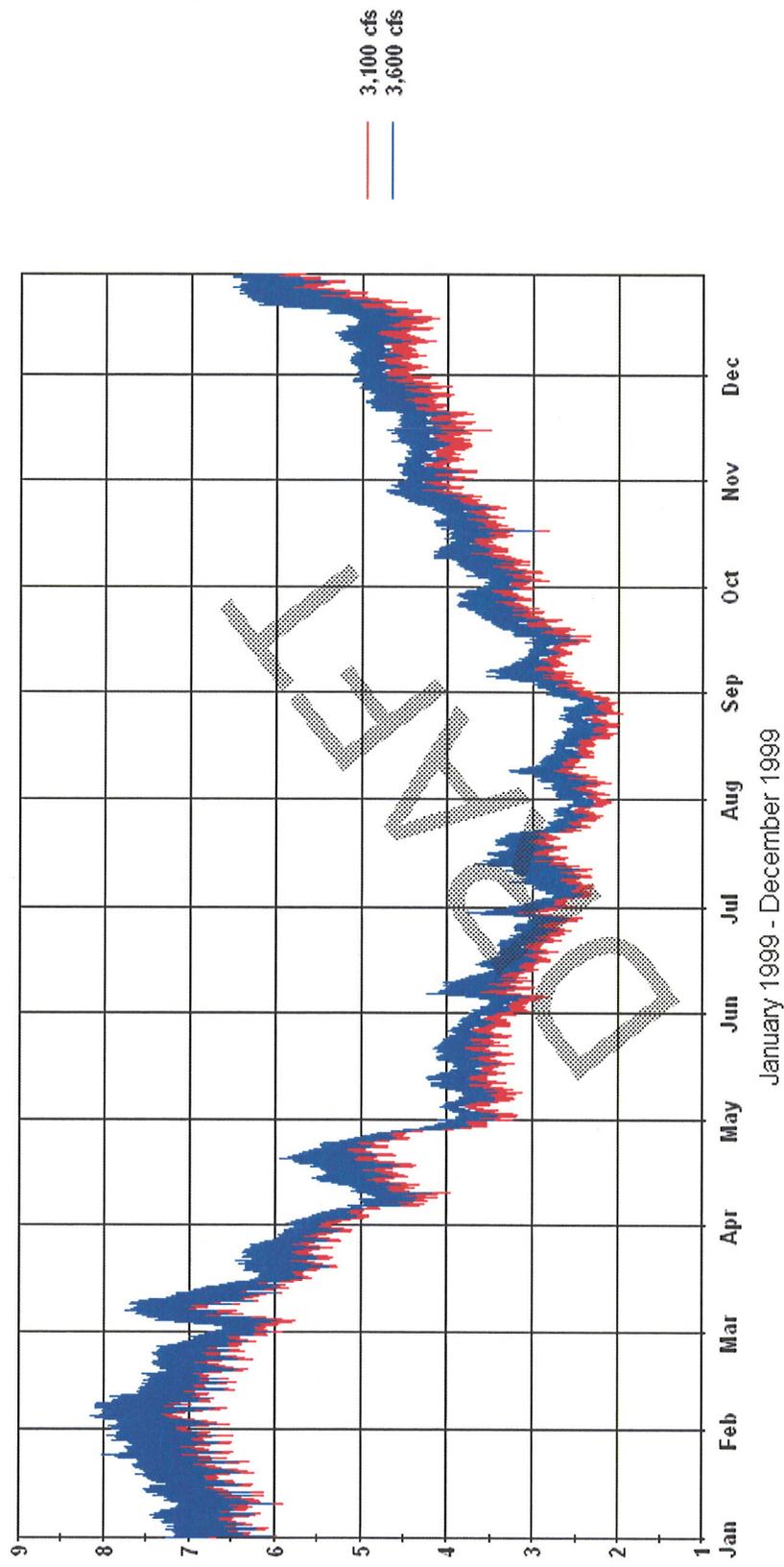


Fig. 16 Simulated surface dissolved oxygen in Savannah harbor